Studies of Polar Processes in the Lower Stratosphere Using UARS MLS Observations

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The Microwave Limb Sounder (MLS) experiments provide vertical profiles of atmospheric composition, temperature, and pressure by measuring millimeter- and submillimeter-wavelength thermal emission from the limb of Earth's atmosphere. The first MLS experiment in space was launched on the NASA Upper Atmosphere Research Satellite (UARS) in September 1991. One of the major objectives of UARS MLS is to improve understanding of stratospheric ozone, particularly the chlorine-catalyzed destruction of ozone in the polar regions of both hemispheres. In addition to measuring ozone, UARS MLS has obtained the first global observations of stratospheric ClO, the predominant form of reactive chlorine involved in ozone depletion. HNO_3, which plays several pivotal roles in determining the cumulative amount of ozone loss, is also measured in the lower stratosphere. HNO_3 is a key component of the polar stratospheric clouds (PSCs) that form in the low temperatures of polar winter, on which the heterogeneous reactions leading to chlorine activation occur. In addition, photolysis of HNO_3 enables a major pathway for chlorine deactivation. It has been argued that denitrification, the permanent removal of reactive nitrogen from the lower stratosphere as HNO_3-containing PSC particles gravitationally settle out, facilitates persistence of enhanced ClO abundances and thus increases ozone destruction. UARS MLS has obtained global measurements of O_3, ClO, and HNO_3 through six complete annual cycles in both hemispheres (and is still taking data, although with greatly reduced sampling frequency), making this data set uniquely suited to addressing some unresolved issues in stratospheric ozone depletion. Here we review results from some recent analyses of UARS MLS data, which include inferring information about PSC composition and formation processes in both hemispheres, investigating the degree of denitrification in Antarctica and its influence on lower latitudes, studying interhemispheric differences and interannual variability in chlorine activation, denitrification, and ozone depletion and the relative importance of denitrification in regulating the extent and duration of enhanced ClO, and discussing the implications of these findings for future Arctic ozone loss.